sat-nms Power Sensor User Manual

User Manual

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1 Introduction

The ***sat-nms*** PowerSensor manufactured by SatService GmbH is a measurement tool which measures the RF output power of 14 or 6GHz satellite communications signals and provides this information both on a web page via an internal web server or as M&C output information for control systems.

The ***sat-nms*** PowerSensor enables the ***sat-nms*** software to perform a precise power measurement even if the monitored and controlled satcom equipment like TWT or SSPA amplifiers or converters do not provide the necessary capabilities or don't have the accuracy. Applications which include a transmit power control loop need to measure the transmit amplifier output power. While many amplifiers provide a built in power sensor with adequate accuracy and resolution, some low-cost models do not. This power sensor is intended to be a supplement to such

This user manual contains all necessary information how to install, setup and operate the ***sat-nms*** PowerSensor. The user manual is available as a printed document and for on-line reading on the power sensor itself as well.

The paragraphs below give a short overview to the contents of this manual.

- Installation: The installation chapter guides through the installation and setup of the power sensor. It describes the mechanical concept of the power sensor box and the assignment of the power sensor's connectors. Finally you learn in this chapter how to set the power sensor's IP address, which is a essential precondition to operate the power sensor by means of a web browser.

- Operation: The ***sat-nms*** power sensor is operated using a standard web browser like the Internet-Explorer on MS Windows based computers. The user interface design is straight forward and clearly structured. Operating the power sensor is mostly self-explanatory. Nevertheless, the 'Operation' chapter outlines the map of web pages which make up the user interface and elaborately describes the meaning of each alterable parameter.

- Remote Control: The power sensor provides a versatile remote control interface. A monitoring & control software may fully operate the power sensor through a TCP/IP network connection. This chapter describes the communication protocol used for remote control and lists all parameters accessible through the remote interface.

- Theory of Operation: This chapter gives a short overview how the power sensor works. This includes a description of the power sensor's electronic concept and the methods of linearization and temperature / frequency response compensation implemented in it.

- Specifications: At the end of the document, the specifications applicable to the ***sat-nms*** power sensor are summarized in this chapter.

Support and Assistance

If you need any assistance regarding our power sensor, don't hesitate to contact us. We would be pleased to help you by answering your questions.

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2 Installation

This chapter describes how to install the ***sat-nms*** power sensor. You find a guide how to connect, configure and mechanically mount the power sensor below.

Before you start, please first read the Safety Instructions chapter below. It contains some important recommendations to prevent damage from the power sensor.

Then, we strongly recommend to do a first setup of the power sensor on a lab desk before installing it at it's final location. This is mainly for the following reason:

To setup the power sensor's IP parameters, the PC used for configuring and the power sensor must either be connected to the same Ethernet hub or must be connected directly with a crossover cable. The initialization program does not work through routers intelligent network switches.

Hence, the typical sequence of tasks when putting an ***sat-nms*** power sensor into operation is as follows:

1. Read the chapter Safety Instructions
2. Set the power sensor's IP address
3. Mechanically mount the power sensor
4. Connect the power sensor to it's signal source, the power supply and the Ethernet network.

2.1 Safety Instructions

Failure to observe all Warnings and Cautions listed below may result in personnel injury and/or equipment damage not covered by the warranty.

- Follow standard Electrostatic Discharge (ESD) procedures when handling an Power Sensor Unit.
- Select and apply the appropriate 24V DC voltage according to the data sheet and documentation **before** connecting power.
- The PowerSensor will be damaged if the total RF input power is higher then specified maximum value. Do not connect the RF input of the Power Sensor to interfaces where the total output power is higher than the specified value of the data sheet or indicated on the PowerSensor.
- In case of an failure don't open the Power Sensor, call SatService GmbH for an RMA number.
- Observe normal safety precautions when operating, servicing, and troubleshooting this equipment.
- Take standard safety precautions with hand and/or power tools.
- When connecting the PowerSensor's fault relay circuit, observe the maximum ratings: 120V D/C, 100mA. The fault circuit is a Photo MOS semiconductor relay which will immediately damaged when connected to higher voltages than specified.

2.2 Setting the IP Address

Before you can operate the power sensor, you need to set the power sensor's IP address. There is a special configuration program on the documentation CD shipping with the power sensor for this purpose. We recommend to configure the power sensor's TCP/IP settings before you install the power sensor at it's final place. To configure the power sensor, the following equipment is required:

- The ***sat-nms*** power sensor itself
- A 24V DC power supply
- A Computer running a Microsoft Windows operating system equipped with CD-ROM drive and Ethernet network card.
- A CAT5 crossover network cable or a Ethernet hub and standard network cables to connect the power sensor and the computer.
- The CD-ROM shipping with the ***sat-nms*** power sensor.

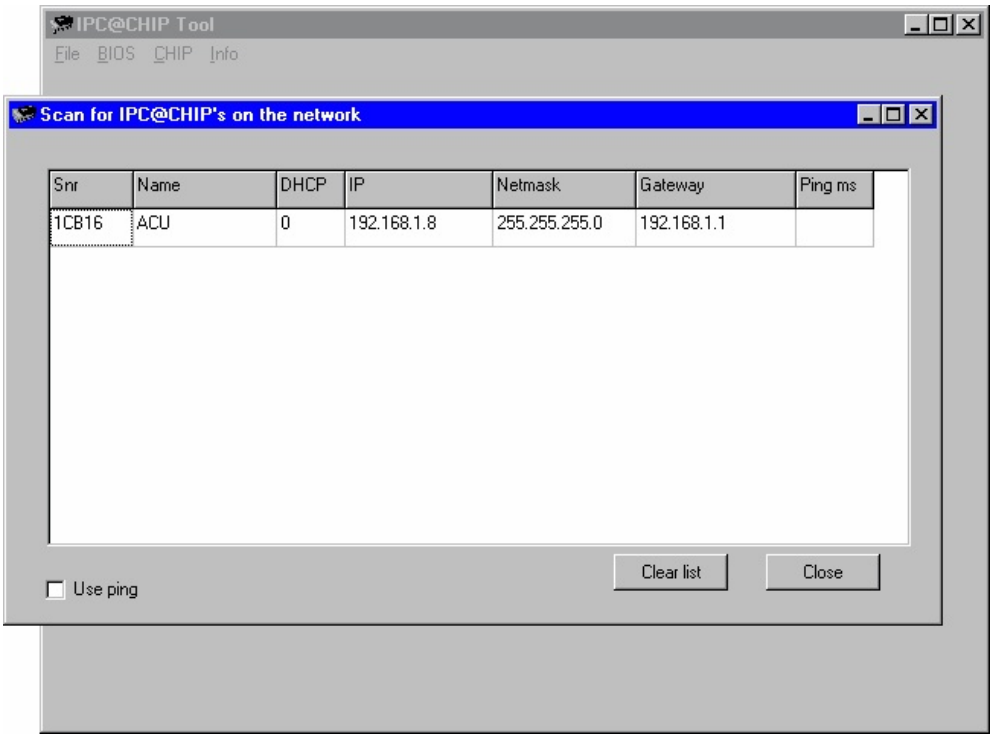
Setting the power sensor's IP parameters now is easily done within a few minutes.

1. First install a network cable between the power sensor and your computer. If you have a crossover cable available, this is very easy: simply put the cable into the network connectors of computer and power sensor. Without a crossover cable, you need to connect both, the computer and the power sensor to the same network hub using two standard network cables. It is essential, that the computer and the power sensor are connected to the same network segment, the configuration program is not able to find the power sensor through routers or network switches.

2. Now power on your computer and connect the power sensor to the 24V DC supply.

3. Insert the CD-ROM into the computer's drive and inspect it's contents through the 'My Computer' icon on your desktop. Double-click to the 'ChipTool.exe' program in the 'ChipTool' directory.

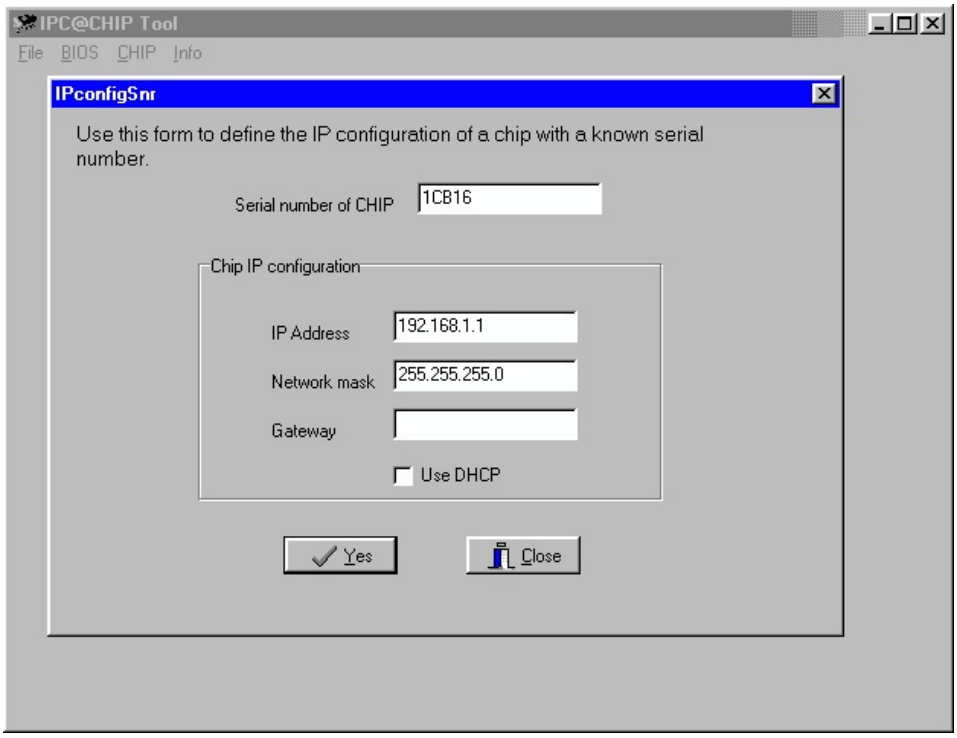
4. When the ChipTool program is running, type CTRL+F to make the program search the power sensor. The program shows a list containing at least one entry describing the actual network parameters of the power sensor.



5. The serial number shown in the first column of the list, must match the serial number printed on the power sensor's enclosure. If the list stays empty, the power sensor is not connected properly. If there are more entries in the list, the configuration program has found other devices in this network segment which use the same technology.

6. Now type CTRL+I to open the IP configuration window of the program. In this form enter the power sensor's serial number, it's new IP address and network mask. If the power sensor later shall be

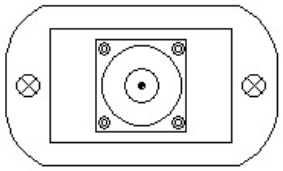
operated through a router, enter the address of the router on the gateway field, otherwise leave this field blanc. Be sure, that the 'DHCP' mark is unchecked. Finally click to the 'Yes' button to set the new parameters at the power sensor



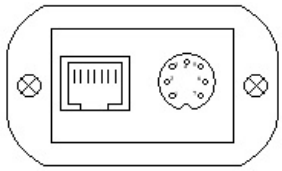
Now the IP configuration of the power sensor is completed. You may finally want to test if the power sensor is reachable now. Start your web browser and type the power sensor's IP address into the URL field of the browser. The power sensor should reply with it's main page, provided that the power sensor and your computer are configured for the same subnet.

2.3 Connecting the Power Sensor

The connectors of the power sensor are placed on both sides. One side contains the RF input connector, the other side the D/C and Data connectors.



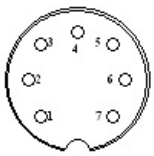
RF connectors



D/C and data connectors

The RF input connector is a make N-type connector, mounted at one front panel of the power sensor enclosure. At the other side, the Ethernet and power supply connectors are mounted. The Ethernet connector is a standard 10 Base-T / RJ45 connector. Use a standard network cable to connect the power sensor to an Ethernet hub. If you want to connect your computer and the power sensor directly without using a hub, you need a crossover cable for this with swapped RX/TX lines.

The power supply connector also contains the fault relay contact. The latter is a floating Photo MOS solid state circuit. In fault state (level below an adjustable threshold) or while the unit is powered off it is in hi-Z state (several MOhms). A resistance below 10 Ohms indicates that the function is OK. The diagram below shows the pin out of this connector (front view).



Connector type:
Binder series 712
subminiature circular
connector (socket)
front view

pin no.	*description*
1	n.c.
2	Fault relay circuit (max. ratings: 120V D/C, 100 mA)
3	Fault relay circuit (max. ratings: 120V D/C, 100 mA)
4	Ground
5	Ground
6	n.c
7	+24V Power Supply

Internally the power sensor interconnects RF ground and D/C ground. In order to avoid ground loops, it is recommended not to connect RF ground and D/C ground at a second point.

2.5 Mechanical installation

The ***sat-nms*** PowerSensor is designed to be mechanically mounted with it's RF input connector. For most setups this will be the most convenient method. However, there are some cases where it is recommended to fix the PowerSensor with a break at a solid surface:

- When operated in an vibrating environment, the sensor may resonate when fixed only with the input connector. This may result in a inadmissible severe vibration at the power sensor itself.
- When the sensor is connected to a SMA connector through an adapter, this connection easily may break as it is mechanically to strong enough not fix the sensor in safe manner.

3 Operation

The ***sat-nms*** power sensor is designed to be controlled over a network link using a standard web browser. This means in practice, that the user interface to the power sensor appears in your browser window after you type in the power sensor's IP address in the address field of the browser program.

Operating the power sensor is mostly self-explanatory.

3.1 The Web-based User Interface

After having connected the to a power supply and set the power sensors IP address, you can access the power sensor's user interface. To do this, start your favorite web browser program (Internet Explorer, Netscape Navigator, Opera or what else Program you prefer). At the address field, where you normally enter the URL of a web page you want to see, type in the IP address of the ***sat-nms*** power sensor you want to control.

The power sensor shows a web page consisting of a navigation bar at the left side of the browser window and the actual readings of the power sensor in the main part of the window. The readings automatically refresh once a second.

The navigation bar at the left contains five buttons which build the power sensor's main menu:

Power Reading	This button switches back to the power sensor's main page you already see when you connect to the power sensor. This page displays the actual readings of the power sensor.
Setup	By clicking to this button you switch to the 'Setup' page where you can view and change the operational settings of the power sensor.
Info	After a mouse click to this button, the power sensor shows a table with information like the serial number of the device or the revision ID and compilation date of the software.
Help	Clicking to this button shows the on-line version of this user manual

3.2 Displayed Readings

The 'Power Reading' page is the main page of the power sensor which shows the actual measurement value and some important settings. Parameter settings reported here, are for information only. To change a setting switch to the Setup page. The 'Power Reading' page automatically refreshes once a second. The table below describes the information shown by this page:

Parameter Name	*Description*
power reading	Shows the actually measured power. The displayed value is the calibrated power at the power sensor's input with the frequency compensation values and an optional level offset added.
frequency compensation	If you have set the frequency value at the Setup page to a non-zero value, the power sensor interpolates this frequency in the frequency response calibration table and includes this value into the displayed power value. The amount of frequency response compensation applied is displayed in this field.
additional level offset	At the Setup page, you may enter an additional level offset which also is included into the displayed value. The value actually used by the power sensor is displayed here.
sensor temperature	Shows the temperature inside the power sensor's enclosure.

averaging	Shows the averaging mode actually used by the power sensor.
input sensivity	Shows the input amplifier range actually used.
alarm threshold	Shows the alarm threshold actually set at the Setup page. If the **displayed power reading** falls below this limit, an alarm is reported and the normally closed alarm contact is opened.
alarm state	Shows the actual alarm state (OK /FAULT)

3.3 Operational Parameters

The page 'Setup' contains the power sensor's operational parameters. The page displays a table with the parameters actually set as a browser entry form. To change a parameter, enter the new value or select the desired option from the drop down list and then click to the 'SUBMIT' button at the bottom of the page. Parameters remain unchanged unless you click to this button.

The table below lists the settings provided by this page.

Parameter Name	*Description*
input sensivity	Sets the sensivity range, the power sensor uses. **AUTO** makes the power sensor select the appropriate range automatically. **LOW** selects the low sensivity range (for high levels). **HIGH** selects the high sensivity range. It is strongly recommended to operate the power sensor with **AUTO** setting.
averaging	Sets the filter, the power sensor applies to the measured values. Valid choices are **OFF** no averaging. **FAST** the sensor displays the average of 8 readings. **SLOW** the sensor displays the average of 48 readings. Averaging is done on the base on the 8 or 48 samples the power sensor recently read.
frequency compensation	Here you may enter the frequency of the measured signal in MHz. If this parameter is not zero, the power sensor looks up the frequency response calibration offset for the given frequency and adds this offset to each measured value before it is displayed. The power sensor accepts integer numbers on the range 0 .. 19000.
additional level offset	The value [dB] specified with this parameter is added to the measured power before it is displayed and compared to the fault threshold value. If value is set to zero, the power sensor shows the power which is measured at it's input connector. The valid range for 'offs' is -99.99 to 99.99.
alarm threshold	Defines the alarm threshold value. If the displayed power value (with any user defines offset and frequency response calibration already applied) drops below this limit, the power sensor reports a 'low signal' alarm and opens the fault relay contact. To disable the threshold, set it to -99.99.
note	You may enter a note / comment here which replaces the 'Power Reading' label on the power sensor's entry page. The label may be set to describe what the power sensor actually is measuring.

4 Remote Control

The ***sat-nms*** power sensor may be controlled remotely by a monitoring and control application through the TCP/IP interface. All communication with the power sensor is made with HTTP get requests. This section gives a detailed description how to read out the power sensor's measurement values and how to set it's operational parameters

4.1 HTTP Protocol

The power sensor implements the 'Hypertext Transfer Protocol' (HTTP, RFC-1945) both, for the user interface and for the M&C interface. All communication, even setting operational parameters, is done with HTTP GET requests. For the user interface, the power sensor replies to requests with HTML pages which display the requested information in a web browser. For the M&C interface, the power sensor replies to requests with an one line text document.

Command parameters to the power sensor are appended as CGI form parameters to the URL (see RFC-1738). The first parameter always is 'fmt=txt' which tells the unit to reply a one line text document instead of a voluminous HTML page.

protocol type
the power sensor's IP address or host name
path
always fmt=txt
other parameter to be set at the power sensor (only valid with /set)
http://192.168.2.63/set?fmt=txt&smod=AUTO ...

4.2 The 'read' command

To read the measurement value from the power sensor, request the 'read' document with a HTTP GET command. The path which must be sent with the GET request is

/read?fmt=txt

Assuming the power sensor listens to the IP address 10.0.0.1, the complete URL for the request is:

http://10.0.0.1/read?fmt=txt

The 'fmt=txt' parameter forces the power sensor to reply a one line text document rather than the HTML coded page which is normally displayed by the web browser.

The power sensor answers a 'text/plain' type document which consist of one line. As shown in the example below, the line consists of a set of keyword - value pairs, separated by '&' characters. Within each pair, keyword and value are separated by the '=' character.

dbms=-12.34&adcv=12345&temp=22.5&sens=LOW&tflt=OK

The format does not use fixed column widths for the values, however the precision of floating point values is always as shown in the example. An application which parses this string should not rely on the order of the values in the line. Future version of the power sensor may provide additional values which not necessarily will appear at the end of the line.

The table below describes the values included in this message:

dbms	The calibrated / temperature compensated power reading in dBm. Any user supplied offset or frequency response compensation is included in this value.
adcv	The raw ADC value without any calibration or compensation applied. The value is in the range 0 .. 65535.

temp	The temperature measured inside the power sensor enclosure. The value is in degree Celsius.
sens	The actual input amplifier sensivity. **sens** is either **HIGH** or **LOW**
tflt	The threshold fault state. if the power reading is below the threshold the value is **FAULT**, otherwise it is **OK**

4.3 The 'set' Command

To set the operational parameters the power sensor, request the 'set' document with a HTTP GET command and append the parameters which shall be set to the URL. The path which must be sent with the GET request is

/set?fmt=txt&...

where ... stands for an arbitrary number of parameter definitions, each consisting of a key word and the associated parameter value, separated by a '=' character. Assuming the power sensor listens to the IP address 10.0.0.1, an example URL for this request is:

http://10.0.0.1/set?fmt=txt&smod=AUTO&offs=0

The 'fmt=txt' parameter forces the power sensor to reply a one line text document rather than the HTML coded page which is normally displayed by the web browser. The parameter definitions 'smod=AUTO' and 'offs=0' shown in the above example make the power sensor to select it's sensivity range automatically and to clear any user defined offset to the measurement value. For a complete list of keywords see the table below.

The power sensor replies to every 'set' request with a complete list of parameters in one line. Like with the 'read' command, the line consists of a set of keyword - value pairs, separated by '&' characters. Within each pair, keyword and value are separated by the '=' character.

smod=AUTO&fltr=OFF&thrh=-99.99&freq=0&fcor=0.00&offs=0.00&snr=0D8F9

The values contained in this list are the values which actually are applying, including the new values read from the 'set' URL. The power sensor does not give a fault message if it receives an invalid parameter definition. It limits parameter values to a valid range or selections instead. If a keyword is not known, it ignores this parameter completely. To read the parameters actually set with changing a value, send a HTTP GET request with 'fmt=txt' as the only parameter.

The table below describes the valid parameter settings (keywords and selection tokens are case sensitive):

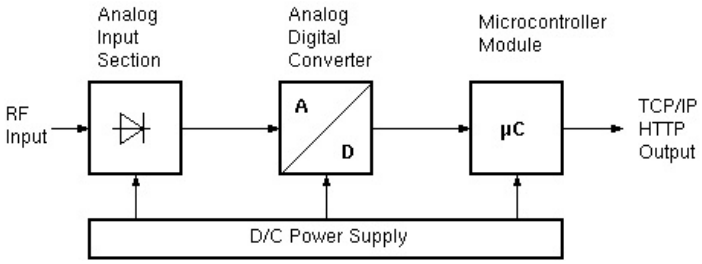
smod	Sets the sensivity range, the power sensor uses. **AUTO** makes the power sensor select the appropriate range automatically. **LOW** selects the low sensivity range (for high levels), **HIGH** selects the high sensivity range. It is strongly recommended to operate the power sensor with **smod=AUTO**. The power sensor uses this as fall-back, if it receives an invalid 'smod' selection.
fltr	Sets the filter, the power sensor applies to the measured values. Valid choices are **OFF**, **FAST** and **SLOW**. **OFF** is the default value the power sensor uses if it recognizes an invalid 'fltr' selection.
thrh	Defines the alarm threshold value. If the displayed power value (with any user defines offset and frequency response calibration already applied) drops below this limit, the power sensor reports a 'low signal' alarm and opens the fault relay contact. To disable the threshold, set it to -99.99.
freq	Defines the frequency of the measured signal in MHz. If this parameter is not zero, the power sensor looks up the frequency response calibration offset for the given frequency and adds this offset to each measured value before it is displayed. 'freq' accepts integer numbers on the range 0 .. 19000.
fcor	The calibration offset, the power sensor actually adds to each measured value due to the

	frequency response calibration. This value is zero unless you set a measurement frequency with the 'freq' parameter. The 'fcor' parameter is read-only, the value only can be set by changing the 'freq' parameter.
offs	The value [dB] specified with this parameter is added to the measured power before it is displayed and compared to the fault threshold value. If 'offs' is set to zero, the power sensor shows the power which is measured at it's input connector. The valid range for 'offs' is -99.99 to 99.99.
snr	The power sensor's serial number. This is a five digit hexadecimal number which uniquely identifies each individual unit. 'snr' is a read-only parameter.

Floating point numbers (as for the 'thrh' and 'offs' parameters) may consist of digits, one optional decimal point and a leading minus sign for negative numbers. The 'freq' parameter is restricted to be a positive integer, it may consist of digits only. Malformed numbers are recognized as zero.

5 Theory of Operation

The ***sat-nms*** PowerSensor consists of the following four major parts:



In the analog input section a microwave detector provides a DC voltage which is depending on the input power range either proportional to the input power or proportional to the input voltage of the input power at the power sensor. The relationship between input power level and the DC voltage to be measured in the last instance by the analog to digital converter is not necessarily to be known exactly, as this is measured and calibrated during the in-factory calibration of each individual sensor.

The DC voltage coming from microwave power detector gets amplified in an operational amplifier. Via a switchable resistor network the gain of the amplifier is controlled by the microcontroller, which allows a so called high and low sensitivity mode. The power sensor software will control this switch and either set the gain to a fixed high or low-sensitivity value or in 'auto' mode take full control about the sensitivity control and depending on the analog to digital converter (ADC) output value switch the sensitivity automatically.

At the output of the operational amplifier the DC voltage which is a measure of the RF input power is provided as input value to the analog to digital converter. The ***sat-nms*** PowerSensor uses a 16 bit ADC, this provides enough resolution to always guarantee the 0,01dB resolution in power level output via the web server.

The complete power sensor is operated by a 24V DC voltage source. This has the advantage that the already existing 24V supplies in a satellite ground station or an M&C System can be used to provide the supply voltage of the power sensor. The 24V supply voltage is routed via a EMV coupled inductor and a transsorber diode which switches off at voltages greater than 36V. This together with a SMD fuse protects the power sensor from to high input voltages or EMV disturbances introduced via the 24V supply line.

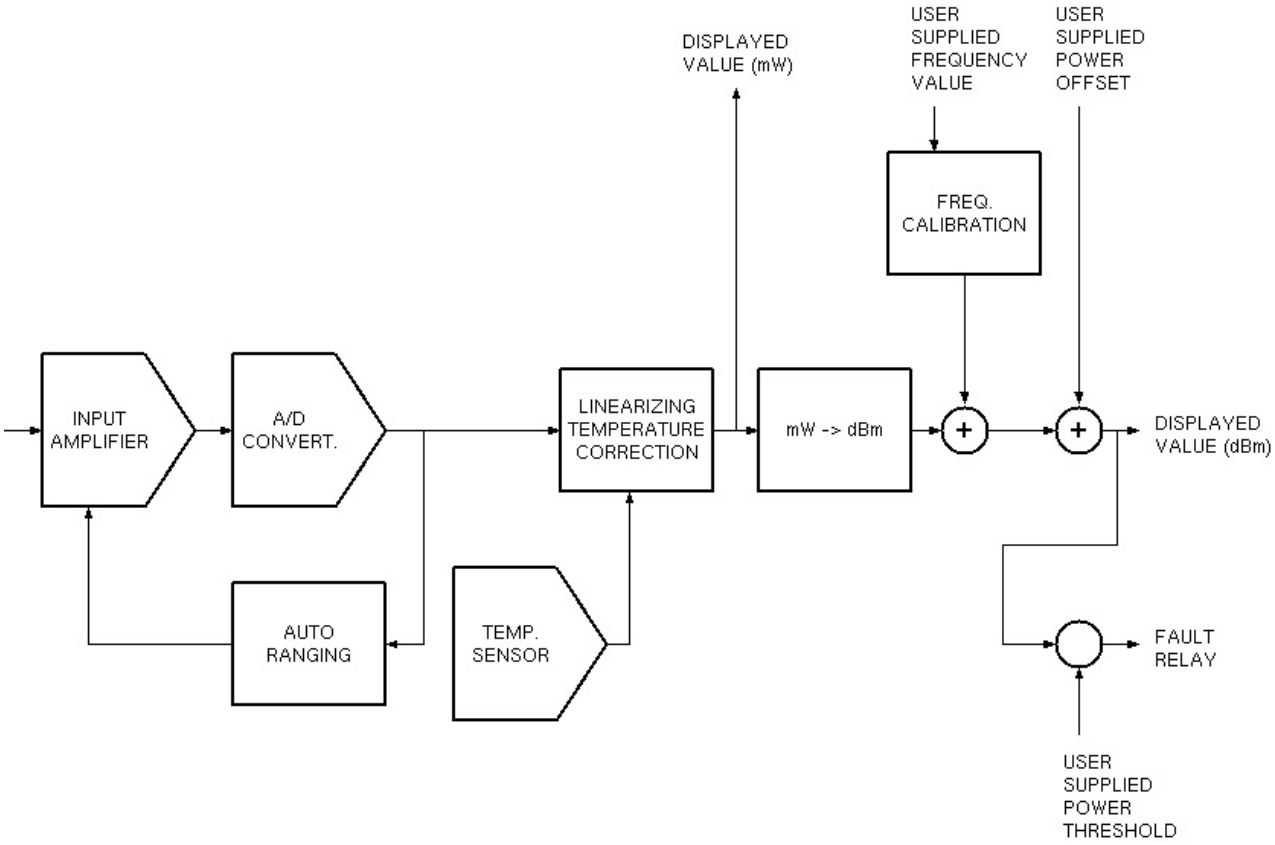
After this input and safety section a DC/DC converter provides the 5V DC voltage necessary for the microprocessor and digital part of the power sensor. Parallel to this a linear voltage regulator provides a so called analogue 5V which is independent from the microprocessors digital 5V supply and therefore more stable and less noise which is better for the analog to digital converter and its analog input section.

Beside the detector diode and the RF matching circuitry the RF sensor module contains a temperature sensor. The temperature registered by this sensor is used by software in the M&C module to perform the temperature compensation of the measured power.

5.1 Linearity and Temperature Compensation

The microprocessor module measures the RF power by means of the A/D converter, measures the temperature and controls the input amplifier sensivity. Using this data, the software calculates the true RF input power by interpolating in calibration tables.

During the in house commissioning each power sensor individually gets calibrated at several temperatures over the whole dynamic range. The calibration tables derived from this are stored on the power sensor. During operation, the power sensor interpolates in these tables to evaluate the true measured power from the raw ADC value and the temperature reading.



5.2 Frequency Response Calibration

The power sensor has a frequency response calibration table built in, which lets the power sensor compensate the influence of the signal frequency to the power reading. This calibration has been made at SatService GmbH, the power sensor shows the power value at it's input connector with this calibration.

If you are going to use the power sensor mounted at a fixed location in an earth station, you might want to include your coupler calibration to make the power sensor show the real amplifier output power. For this reason it is possible to replace the calibration table in the power sensor.

The calibration table is a plain text file called FCORR.TXT. It contains a table where each line consists of a frequency value (MHz) and the correction value (dB), separated by a semicolon. The file should not contain any other information, no space characters and no empty lines. You may prepare this table with a spread sheet program like Microsoft Excel and export the table as a semicolon separated 'csv' table.

To upload your own FCORR.TXT file to the power sensor, use a standard FTP client program at the command line. Replace the default IP address from the example below with the address the power sensor is actually listening to.

```
ftp 192.168.2.62
user name: service
password: service
ren FCORR.TXT FCORR.BAK
put FCORR.TXT
bye
```

The suggested command sequence in the example above contains the line `ren FCORR.TXT FCORR.BAK`. You should do this once the before you upload a FCORR.TXT file the first time. This saves

the original calibration table into the FCORR.BAK file and lets you restore the factory calibration at a later time.

Never change or delete the 'H*.TXT' / 'L*.TXT' calibration files on the power sensor. If these files are damaged, the sensor must be returned to SatService GmbH and calibrated again. There is no way to calibrate the power sensor on-site!

6 Specifications

RF Specification	
Input frequency range (to be defined at order)	5,8 to 6,6GHz (PSMC) 13,75 to 14,5GHz (PSMKu)
Input Connector	N male 50Ohm
Input Return Loss	> 16dB
Input Power Measurement Range	+15 to -18dBm
Resolution of power level	0,01dB
Linearity failure	+/-0,7dB
Averaging function selectable	High, Low, Auto
M&C Interface Specification	
Ethernet interface for M&C and user interface	10-Base-T
User Interface	Via any Web Browser
M&C Interface for remote monitoring & control	Via http GET requests
Summary fault / level alarm indication	Photo MOS Relay contact (120 V D/C, 100 mA)
Electrical and Mechanical Specification, Environmental conditions	
Supply Voltage, all stabilization necessary should be performed on the board	22V to 28V unregulated DC
Connector for 24V Supply and Alarm contact	Binder Series 712 7PIN
Temperature range	5° to 50° C
Humidity	up to 90% non condensing
Compact Module	185x60x35mm